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(71) Applicant: **BP Chemicals Limited**
Belgrave House 76 Buckingham Palace Road
London, SW1W 0SU(GB)

(72) Inventor: **Jackson, David Andrew, BP**
Chemicals Limited
Salt End

Hull HU12 8DS(GB)

Inventor: **Parker, David Andrew, BP**
Chemicals Limited
Salt End

Hull HU12 8DS(GB)

Inventor: **McGee, Edward, BP Chemicals**
Limited

Belgrave House, 76 Buckingham Palace
Road
London, SW1W 0SU(GB)

(74) Representative: **Krishnan, Suryanarayana**
Kalyana et al
BP INTERNATIONAL LIMITED Patents &
Agreements Division Chertsey Road
Sunbury-on-Thames Middlesex TW16
7LN(GB)

(54) **Ensiling composition.**

(57) This invention relates to aqueous compositions suitable for ensiling substrates said composition comprising formic acid and octanoic acid. The composition may contain in addition other components such as propionic acid and ammonia to improve ease of handling.

The feature of the invention is that octanoic acid, which when used alone, has no ensiling or fermentation activity, has enhanced ensiling activity when used in conjunction with formic acid and thus increases nutritionally desirable sugars in the ensiled product.

EP 0 411 827 A1

ENSILING COMPOSITION

The present invention relates to a composition for use in silage preparation which enables the enhancement of residual sugars during fermentation of silage.

Formic acid is well known to be an excellent silage additive. The acid, usually at about 80%w/w concentration in aqueous solution, is usually applied on the substrate to be ensiled at the rate of about 2-4
5 litres per ton. At these levels lactic acid fermentation occurs. In order to restrict the fermentation process and to enhance the residual sugar content of the ensiled substrate e.g. grass, it is necessary to increase the application rate of formic acid (85%w/w) to about 6 litres per ton.

However, increasing formic acid in silage not only makes the silage less palatable to the animals but inevitably increases acidity of the silage thereby causing corrosion problems during storage etc. Moreover,
10 formic acid has relatively low antimicrobial activity and hitherto this has been mitigated by the use of various quantities of sterilants such as e.g. formaldehyde.

It has now been found unexpectedly that a higher carboxylic acid when used together with formic acid in appropriate proportions can mitigate these effects.

Accordingly, the present invention relates to an aqueous composition suitable for use as an ensiling
15 agent comprising a combination of formic acid and octanoic acid.

The relative proportions of formic acid and octanoic acid in the composition are suitably such that for every 100% w/w of an aqueous solution of formic acid (containing 85% w/w formic acid) there is present suitably from 0.5-10% w/w, preferably from 2-8% w/w of octanoic acid.

The composition is most suitable for ensiling substrates and is preferably applied to the substrate in an
20 amount ranging from 0.35 to 0.9% w/w, most preferably from 0.4-0.7% w/w of the substrate.

The compositions of the present invention may contain in addition other components including propionic acid and ammonia depending upon the activity desired. For instance in a formulation containing both these additional components, formic acid and octanoic acid, the ratio of propionic acid to octanoic acid is suitably at least 2 : 1 w/w, preferably from 3 : 1 to 5 : 1 w/w; and the molar ratio of formic acid to
25 ammonia in said composition suitably is at least 4 : 1, preferably from 4 : 1 to 8 : 1, typically 6 : 1.

Thus a typical composition of this type may contain 75.7% w/w of an aqueous solution of formic acid (corresponding to 64.345%w/w actual formic acid), 10.0% w/w propionic acid, 2.0% w/w octanoic acid and 12.3% w/w aqueous ammonia. (corresponding to 4.06% w/w actual ammonia).

The composition may be applied to the substrate either by direct mixing of the harvested substrate with
30 the ensiling formulation or by impregnating a particulate and porous carrier material as pumice, vermiculite, perlite dried beet pulp or dried citrus pulp with the formulation and then uniformly distributing the impregnated carrier into the substrate to be ensiled.

Thus, according to a further embodiment the present invention is a process for ensiling substrates as hereinafter defined, said substrate being treated with an aqueous composition by mixing said composition
35 comprising a mixture of formic acid and octanoic acid thoroughly with the substrate to be ensiled.

By the term "substrate" is meant here and throughout the specification grass, agricultural crops and whole plant materials used in preparing animal feedstuffs such as grass, lucerne, alpha alpha, barley, wheat, oats, rye, maize, rice, hay, silage, tick beans, soya beans, sunflower seed, rape seed, groundnuts.

A feature of the invention is the synergistic effect observed by using a combination of these acids
40 whereby the C₈ acid not only aids inhibition of the rapid fermentation induced by relatively low levels of formic acid so as to reduce levels of lactic acid formed and enhance residual sugars in the ensiled substrate but also confers a preservative antimicrobial effect on the substrate treated.

Moreover, the level of formic acid addition can be reduced in spite of the C₈ acid which, when used alone, has little or no known ensiling or fermentation activity.

The present invention is further illustrated with reference to the following example and accompanying
45 graph.

Example 1

50

The experiments reported below were designed to compare the effect of (i) formic acid (85%w/w aqueous solution) applied at 1,3,5 and 7 litres/t, alone and (ii) as a blend thereof with octanoic acid on the biochemical changes occurring during the ensilage of lucerne (*Medicago sativa*).

The residual sugars (water soluble carbohydrates) found in the silage after 100 days peaked at the application rate of 5 litres/t. At these levels fermentation of the silage was clearly restricted and the inclusion

of octanoic acid (5%w/w) increased the efficacy of the additive. This is graphically shown in Figure 1.

Examples 3 and 4 (Laboratory Scale):

During the natural fermentation process of ensilage, the desirable sugars found in grass are converted to undesirable lactic acid by the epiphytic microflora. This results in the production of a forage that is deficient in the desirable sugars and therefore the efficiency of utilisation by the animal is reduced. The formulations of the present invention were developed specifically to suppress this natural fermentation process and therefore enable these feedstuffs to retain many of the nutritional advantages of fresh grass feed.

The following Examples 2, 3 and 4 demonstrate this effect. In these Examples the ensiling formulation used contained:

Aqueous formic acid - 75.7%w/w (64.345%w/w actual formic acid)

Propionic acid - 10.0%w/w

Octanoic acid - 2.0%w/w

Aqueous ammonia - 12.3%w/w (4.06%w/w actual ammonia).

Example 2 (Farm Trial):

The study was carried out on a dairy farm.

A total of 1300 tonnes of grass was ensiled on 3rd July, 1989 with approximately 500 tonnes treated with the formulations specified above at 6 litres/tonne level by thoroughly mixing the formulation with the chopped grass as it was being harvested. The remainder was left untreated. In both cases the grass was stored under substantially anaerobic conditions for 50 days.

Thereafter the ensiled samples were analysed for standard nutritional parameters using the techniques described in "The Analysis of Agricultural Materials", Ministry of Agriculture Food and Fisheries, RB 427, 2nd Edition, published in 1981 by Her Majesty's Stationery Office, London. The appropriate pages relevant for the specific analyses are indicated, where applicable, in the Tables below:

Results			
	TREATED*	UNTREATED	PAGE REF
Dry Matter (%)	39.3	35.2	74
pH	4.4	4.1	87
Ammonia N as % Total N	5	5	Steam distillation
Crude Protein	15.5	12.9	130
Mad Fibre	53.6	55.9	82
Ash	7.9	7.6	16
Sugars	20.5	6.3	36
Digestibility (estimate)	58	63	-
Lactic acid	0.96	8.03	204

* According to the invention.

The formulations of the present invention restricted the natural fermentation process producing a forage high in residual sugar and low in fermentation products e.g. lactic acid.

The following Examples 3 and 4 were carried out in a laboratory. Fresh grass was ensiled in mini silos (5kg) by mixing the grass in chopped form with the formulations referred to above Using commercial mixing equipment. The mixture was ensiled in anaerobically sealed containers for 80 days under ambient conditions. The container was then opened and the contents sampled for analysis as previously stated in Example 2 above.

Example 3

Results			
	TREATED*	UNTREATED	PAGE REF
Dry Matter (%)	22.4	21.8	74
pH	4.8	4.0	87
Ammonia N as % Total N	10	10	Steam distillation
Crude Protein	14.2	13.6	130
Mad Fibre	58.0	53.1	82
Ash	12.5	13.1	16
Sugars	13.5	1.4	36
Digestibility (estimate)	54	56	-
Lactic acid	0.00	7.56	204

* According to the invention.

The formulations according to the invention restricted the natural fermentation process producing a forage high in residual sugar and no detectable fermentation products (lactic acid).

Example 4

Results			
	TREATED*	UNTREATED	PAGE REF
Dry Matter (%)	32.0	32.1	74
pH	4.2	4.1	87
Ammonia N as % Total N	7	7	Steam distillation
Crude Protein	19.9	19.0	130
Mad Fibre	51.3	49.8	82
Ash	18.5	18.0	16
Sugars	6.1	2.0	36
Digestibility (estimate)	52	53	-
Lactic acid	3.55	5.86	204

* According to the invention.

The formulations according to the present invention restricted the natural fermentation process producing a forage high in residual sugar and low in fermentation products e.g. lactic acid.

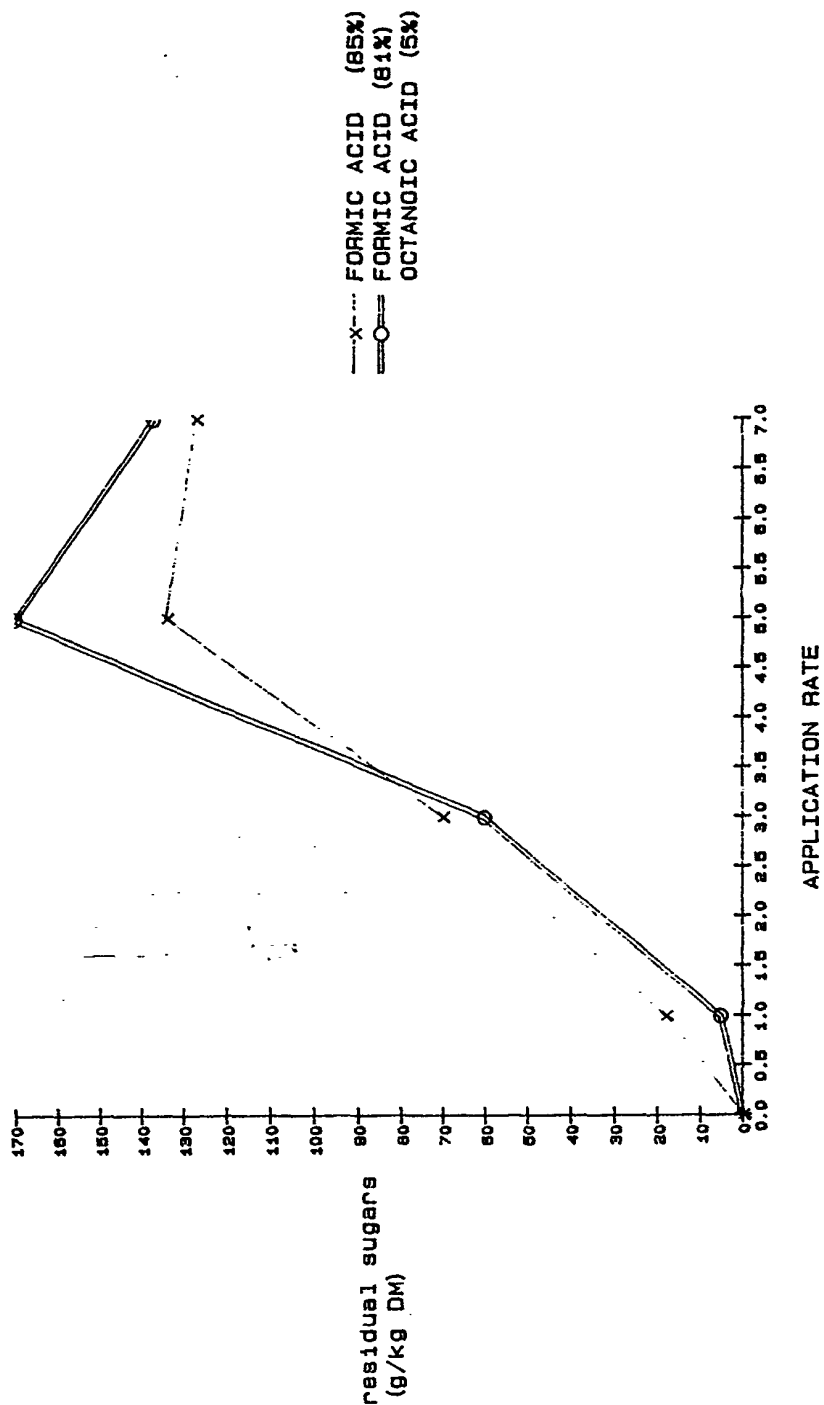
Claims

1. An aqueous composition suitable for use as an ensiling agent comprising a combination of formic acid and octanoic acid.
2. A composition according to Claim 1 wherein the aqueous solution has from 10 to 50%w/w of water.
3. A composition according to Claim 1 or 2 wherein said composition contains 0.5-10%w/w of octanoic acid per 100%w/w of aqueous formic acid (containing 85%w/w of formic acid).
4. A composition according to any one of the preceding Claims wherein said composition comprises formic acid, propionic acid, octanoic acid and ammonia.
5. A composition according to Claim 4 wherein the ratio of propionic acid to octanoic acid is at least 2:1 w/w; and the mole ratio of formic acid to ammonia is at least 4:1.
6. A composition according to Claim 4 or 5 wherein the composition comprises:
 - aqueous formic acid - 75.7%w/w (64.345%w/w actual formic acid)
 - propionic acid - 10.0%w/w

octanoic acid - 2.0%w/w and
aqueous ammonia - 12.3%w/w (4.06%w/w actual ammonia).

7. A process for ensiling a substrate with a composition according to any one of the preceding Claims wherein said formulation is applied to the substrate by impregnating a porous particulate carrier material with the composition and uniformly distributing the impregnated carrier in the substrate to be ensiled.
8. A process for ensiling a substrate according to Claim 7 wherein the carrier material is selected from pumice, vermiculite, perlite, dried beet pulp and dried citrus pulp.
9. A process for ensiling a substrate with a composition according to any one of the preceding Claims 1-6 wherein said substrate is treated with the aqueous composition by mixing said composition thoroughly with the substrate to be ensiled.
10. A process according to Claim 7, 8 or 9 wherein the substrate is a whole plant material selected from one or more of grass, lucerne, alpha alpha, maize, rice, hay, silage, tick beans, soya beans, sunflower seed, rape seed and groundnuts.

FIGURE 1.
EFFECT OF THE INCLUSION OF OCTANOIC ACID ON THE
PERFORMANCE OF FORMIC ACID AS A SILAGE ADDITIVE
TO INCREASE RESIDUAL SUGARS





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EUROPEAN SEARCH REPORT

Application Number

EP 90 30 8186

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-2 653 448 (BP CHEMICALS LTD) * Claims 1,7,8; page 4, paragraph 3; page 6, paragraph 3 - page 7, paragraph 1 *	1,2,9, 10	A 23 K 3/03
A	GB-A-1 481 961 (BP CHEMICALS INTERNATIONAL LTD) * Claims 1,2,4,6,9 *	1,9,10	
A	JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE, vol. 26, no. 2, 1975, pages 219-228, Society of Chemical Industry, Oxford, GB; M.K. WOOLFORD: "Microbiological screening of the straight chain fatty acids (C1-C12) as potential silage additives" * Page 223, tables 1,2 *	1	
A	SOVIET INVENTIONS ILLUSTRATED, week C26, 6th August 1980, astract no. 45985C/26, Derwent Publications Ltd, London, GB; & SU-A-697 129 (POLT PIG BREEDING) 28-11-1977 * Abstract *	1	
A	JOURNAL OF THE SCIENCE OF FOOD AND AGRICULTURE, vol. 26, no. 7, 1975, pages 941-948, Society of Chemical Industry, Oxford, GB; Y. OHYAMA et al.: "The effect of some additives on aerobic deterioration of silages" * Whole document *	1	
A	DE-A-2 019 972 (BASF) * Claims 1,3,4 *	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31-08-1990	Examiner DEKEIREL M.J.
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document</p>			